

## STUDIES ON TUNICATA.

## No. I.

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(*From the Physiological Laboratory of the University of Sydney.*)

(Plates xxv.-xxvii.).

*Introduction.*—In the series of papers hereby commenced, I hope from time to time to contribute to our knowledge of the Australian Tunicate fauna.

Thanks to the excellent work of Professor Herdman, the student of Australian Tunicata is very fortunately situated. In his "Catalogue of the Tunicata in the Australian Museum," Professor Herdman gave a classified list, with bibliographical references, of all the species recorded from the Australian coasts. That list is a guide to past work, and such a guide is invaluable.

Of the one hundred and eighty-three species recorded, the greater number have been well and adequately described; there still remain unattached names, notably those of Quoy and Gaimard, and of Stimpson.

In these papers it is my purpose to record the recognition of these poorly described species as opportunity offers, to note extensions of ranges of those better known, to describe any new forms that may occur to me, and to record any other observations that may be of interest to the general subject.

For the guidance of collectors who may be willing to assist me with material, I may say that I should like the specimens to be placed in 5 % formol (2 % formaldehyde) in sea-water directly collected, and after two or three days to be transferred to 50 %

alcohol. Simple ascidians with tough tests should be carefully slit open distal to the siphonal apertures. Precise information as to habitat and degree of rarity or otherwise should, whenever possible, be made available; it is often by such information, as much as by the characters of the animal, that one is enabled to identify the meagrely described species, *cf.*, *Ciona intestinalis* var. *sydneyensis*, and *C. intestinalis* var. *diaphanea*, below.

Genus *SIDNEIODES*, gen.nov.

*Colony* formed of a number of shortly pedunculated lobes, arising from a flattened base.

*Systems* irregular, simple, one, two or three to a lobe.

*Ascidiozooids* elongated and distinctly divided into regions, marked constriction between abdomen and postabdomen, oral apertures six-lobed, atrial simple, not provided with a languet.

*Test* soft cartilaginous, but tough and membranous.

*Branchial sac* very well developed, long and narrow.

*Alimentary canal* long, forming an open loop; stomach thick, smooth.

*Postabdomen* fairly long, torpedo-shaped.

*Reproductive organs*: testes in the postabdomen; ovary in the atrial chamber.

*Type*: *S. tamaramæ* Kesteven (*infra*).

The form for which this genus is proposed, differs from other Ascidians in the situations of the two gonads; since this character is described in detail in the specific description, it need not be further referred to here.

Disregarding, for the present, the character of the genitalia, the following points of similarity and dissimilarity to members of other genera are worthy of notice.

*Sidneioides* may be said to combine the characters of *Sidnyum* and *Polyclinum*; in general features it closely resembles both, differing from the former and resembling the latter in having the wall of the stomach smooth; and resembling the former and differing from the latter in the absence of an atrial languet.

I propose to regard the novelty as a member of the POLYCLINIDÆ, intermediate between *Polyclinum* and *Sidnyum*.

If, as Herdman\* has suggested, *Aurantium* is a group of insufficient importance to warrant its separation from *Polyclinum*, then it is only necessary to modify his dichotomous key (*l.c.*, p. 616) to the genera of the POLYCLINIDÆ as indicated below, to make a place for the new genus.

- 6 { Both gonads in the postabdomen..... *Polyclinum*.  
     { Ovary in the atrial cavity, testes in the postabdomen..... *Sidneioides*.

SIDNEIOIDES TAMARAMÆ, sp. nov.

(Plates xxv., fig. 9; xxvi., figs. 1-6).

*External appearance.*—The colony consists of many separate, shortly pedunculated lobes closely packed together to form a bun-shaped, or hemispherical ascidiarium. The peduncles of the individual lobes are all united to a flat basal, stolonial expansion which, in turn, is attached to a substratum of rock and barnacles. This stolonial basis is only about one-half the diameter of the colony, so that the lobes radiate as from a common centre. The colour of the ascidiarium is dull grey, due to the presence of small, densely packed, incrusting sand-grains imbedded on the surface of the test. The distal surface of each lobe is flat, and bears round its edge a slightly prominent ridge, and towards its centre, one, two or three fairly prominent papillæ, the orifices of as many cloacal chambers. The largest colony of normal growth had a maximum length of 40 mm., and diameter of 60 mm. (Plate xxvi., figs. 5-6). The ascidiarium above described is such as grows on a flat surface; those growing in confined rock crevices adapt themselves to the irregularities of their situation and assume very various shapes.

*The ascidiozoids* (Plate xxv., fig. 9) are all arranged vertical to the free surface, and, therefore, like the lobes, radiate as from a centre; they present the tripartite division of the body characteristic of the family. The total length varies from 17-23 millimètres. The relative proportions of thorax to abdomen to postabdomen are approximately 13:9:9. The diameter of the

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\* Herdman, Journ. Linn. Soc. xxii., 1891, p. 618.

thorax is fairly constantly 2.5 mm., that of the abdomen half of this, and of the postabdomen a little more than half this again. The length of the postabdomen is variable. In preserved specimens the six-lobed oral siphon (Pl. xxv., fig.9) is found to be well, though not deeply retracted; the simple atrial aperture, nearly level with the oral, is probably much nearer its normal position. The vascular appendages are simple tubular unbranched structures.

*The common cloacal chambers* are small and flattened in the plane of the surface of the colony. From each chamber a variable number of tubular diverticula extend between the ascidiozooids to their respective atrial siphons. Those to the nearest individuals take a nearly straight course; to those more distant the tubules radiate out parallel and close to the surface of the test, and then dip directly down to their destination. These tubules, though composed of test, lined by an epithelium, are not merely excavated in the test, but lie more or less free and often come away attached to the siphon (see fig.9).

*Systems*, though undoubtedly present, are so variable as to be undefinable; there were apparently ten individuals in one system counted.

*The test*, owing to its strengthening of sand-grains, is firmer on the surface than within; in consistency it is intermediate between cartilaginous and gelatinous; and, owing to the close packing of the ascidiozooids, which reduces the test to a minimum, it may be aptly described as membranous. The cells are very numerous, and of two kinds. The more numerous form (Plate xxvi., fig.3) has an approximately oval shape rendered irregular by the expanded bases of extremely fine dendritic processes of great length, given off from both ends. These processes are very occasionally seen after staining with eosin, but, on using Van Gisson's micro-acid fuchsin, they show up very distinctly, and by a sufficiently high magnification the test is shown to be pervaded with these processes; their tenuity is of about the same order as that of white fibres of mammalian areolar tissue. Cells of the second form are of the usual spindle type; a few of the normal

stellate type are also present, but these are rare. Bladder and pigment cells are absent. Vessels also are absent; their function is probably subserved to some extent by the lacunæ in which the spindle cells lie; one quite often sees the cells arranged in linear series, apparently in actual contiguity, in which case their lacunæ must be continuous.

*The mantle* is fairly strong; retractor muscle-bands only are present, and these are all evanescent before reaching the posterior end of the thorax. A sphincter musculature is present round both siphons.

*The branchial sac* (Plate xxv., fig.9) is remarkably long and narrow. There are eleven to thirteen rows of about twelve, long, round-ended stigmata on each side. The ciliated border cells present each a convex edge, so that the margin of the stigmata is undulating. The transverse bars are wide and not provided with membranes on the branchial aspect.

*The endostyle* is simple and straight.

*The dorsal lamina* is represented by languets equal in number to the transverse bars (Pl.xxvi., fig.4).

*The tentacles* are about eight in number, simple, filiform, fairly long and relatively stout.

*The dorsal tubercle* is of circular form, apparently with a simple aperture.

*Alimentary canal* (Pl. xxv., fig.9).—The œsophageal aperture forms the greater part of the posterior boundary of the pharynx. The œsophagus is thin-walled and short; it curves inwards and junctions with the oval thick-walled stomach on its inner aspect, beyond its anterior end. The wall of the stomach is neither folded nor irregularly thickened. The gut presents three distinct segments. The first, which may be regarded as the small intestine, is a short segment, with thin, somewhat folded walls, which pass backwards from the posterior end of the stomach. Following this is the thicker-walled large intestine, a somewhat longer, markedly stouter segment with quite smooth walls, which forms the posterior boundary of the abdomen, curving across from the ventral to the dorsal side and somewhat to the right. Defined

from the intestine by a constriction is the rectum, which extends straight up to the right of and dorsal to the rest of the canal, and opens in the peribranchial cavity about one-third of the way up the thorax. The small anal aperture is situated at the base of a four-lobed funnel-like expansion (Pl.xxvi., fig.4).

*Reproductive organs.*—The testes are placed in the postabdomen. The spermatic vesicles are arranged in grape-like clusters, and from each lobe there passes a vas efferens. The vas deferens is situated on the ventral side of the postabdomen; it curves across to the opposite side along the distal edge of the large intestine, and thence it runs parallel to the rectum to terminate nearly on a level with the anus (Plate xxvi., fig. 4). The ovary is situated in the peribranchial cavity, on a level with about the middle of the thoracic portion of the rectum (Pl. xxv., fig. 9; Pl. xxvi., fig.4). The peculiarity of this situation caused some doubts as to the correctness of the observation; the specimen figured was, therefore, imbedded and sectioned; the evidence of the sections conclusively settles all doubt. A representation of a section of the ovary is shown on Plate xxvi., fig. 1. This particular ovary contains five ova of large size, two of which may be described as ripe, the others being somewhat smaller. The germinating epithelium is confined to the anterior wall, and here alone are ova of small size seen; the rest of the wall of the ovary is lined by a low cubical epithelium. The ova of largest size are invested by the flattened "test-cells," some of which may be seen within the peripheral portion of the ovum. The half-grown ovum is apparently invested by three or four layers of low cubical cells; besides this envelope of test-cells the half-grown ova are separated, one from the other, by trabeculae of low epithelioid cells on a thin connective tissue basis, each, however, lying free in a cavity larger than itself. The stroma surrounding the youngest ova invests them closely. No oviduct is to be seen, the ripe ova being apparently set free by the rupture of the wall of the ovary.

It is of interest to note that the species is probably self-fertilising. Ova in all stages are present in the ovary, embryos in several stages of development in the peribranchial cavity

(Pl. xxvi. fig. 2), and mature spermatozoa obliterate the lumen of the vas deferens.

An incubatory pouch is not present; the embryos are hatched in the peribranchial cavity.

Budding is apparently postabdominal; blind vascular diverticula of various lengths are present at the distal end of the postabdomina of many individuals examined.

Type to be presented to the Australian Museum.

Hab.: Tamarama Bay, Sydney, New South Wales (H.L.K.). Tamarama is a small sandy bay on the ocean coast, about four miles from Sydney. Upwards of a dozen colonies of various sizes and shapes were seen attached to the sheltered sides of rocks near low-water mark, on two occasions during January, 1909.

CIONA INTESTINALIS, var. SYDNEIENSIS Stimpson.

(Plate xxvii., figs. 13-19).

*Ascidia sydneyensis* Stimpson, Proc. Acad. Nat. Sci. Philadelphia, vii., 1855, p. 387.

*Ciona intestinalis* (?) Linné, Herdman, Cat. Tunicata Aust. Mus. 1899, p. 9.

Except *Cynthia præputialis* Heller, and *Boltenia pachydermatina* Herdman, this variety of the "common European species" is the most abundant ascidian in the littoral zone of Port Jackson, Broken Bay, or Port Hacking; and, on dredging almost anywhere in Port Jackson, it comes up in great abundance, attached to seaweeds and stones.

Owing to the brevity of his descriptions, the recognition of Stimpson's species must always remain a matter of some doubt. In the present case, however, the peculiar test and description of habitat allow the local student to speak with confidence. Stimpson described six simple ascidians from Port Jackson; of these one alone is described as having a "thin often translucent test." That one is *A. sydneyensis*, the description of which applies equally well to three Port Jackson ascidians, viz., *Ciona intestinalis* (?) Linné (Herdman), *Ascidia incerta* Herdman, and



*A. pyriformis* Herdman. It is described as being "gregarious, several specimens growing together in one mass"; and it was "found near low-water mark, among rocks" in Port Jackson. Such is the common habit and habitat of the species here associated with the name. That Stimpson collected in a locality affected by this form, is proven for us by the fact that the Holothurian, *Synapta dolabrifera*, which he described at the same time, is very constantly found in similar situations. Finally, the other two species to which his description might apply are rare, this one is extremely common, and Stimpson's stay in Sydney was of very short duration.

The differences between var. *sydneyensis* and the typical form have already been noted by Herdman (*loc. cit.*). I incline to the view that our form should rank as a distinct species, but my European material does not permit me to make satisfactory comparisons; for that reason I append a description of the form, and content myself with drawing attention to the name which is to be applied, if that view prove correct.

*External appearance.*—The shape is elongate-ovate, somewhat flattened from left to right, roundly truncate posteriorly, tapering anteriorly to the siphons. The atrial siphon, when both are fully extended, is somewhat shorter, and is placed a little further back than the branchial. In preserved specimens both siphons are usually retracted to such an extent that the anterior end is abruptly truncate. In the body taken from the test (Pl. xxvii., figs. 13, 15, 16), the atrial siphon may appear the longer, the branchial being much more strongly retracted. Specimens from a sandy bottom are attached by the posterior end only, usually several together; and in such cases the tests are quite commonly completely fused. Specimens on the rocks may be attached by the posterior end only, or along the length of the dorsal side; the attachment is usually strengthened by the development of root-like processes of the test. The size and proportions are extremely variable. A large specimen will measure as much as 10 centimètres in length, with a maximum diameter of 3·3 centimètres. The largest specimens are those obtained



with the dredge; they are always more flaccid than those from the tidal zone, and the body within the test is disproportionately small. The branchial aperture is eight-lobed, the atrial six-lobed, both very prominent in living specimens but completely retractile. The siphonal lobes are all ornamented towards their base with a small bright red spot. The colour of living specimens is light sea-green, preserved specimens are yellowish or grey.

*The test* is moderately thick, but transparent. The external layer is firm and tough, the innermost layers so gelatinous, as to be almost viscid. Test cells are of the typical stellate variety; their processes are small and few, so that they appear round or oval at first sight.

*The mantle* anteriorly is strong, muscular, and perfectly translucent. The opacity of the anterior end is not pronounced in living specimens; it is due to the abundance of muscular tissue which, in preserved specimens, being contracted, intensifies the opacity by puckering the mantle. The longitudinal muscle bands are external to the transverse; each arises by two thin cords from the adjacent sides of contiguous siphonal lobes (Pl. xxvii. fig. 13) on the branchial siphon. At the base of the atrial siphon these bands divide and, coursing across the left and right towards the ventral side and posteriorwards, broaden out and become evanescent before the posterior end is reached. The dorsal side and posterior end of the mantle bear transverse muscle-fibres only.

*The branchial sac* is delicate; its vessels of attachment, though fine, are stronger than the sac itself. There are no folds present. The transverse vessels are alternately large and small; the internal longitudinal vessels are about equal to the larger transverse in size. The meshes are broader than long, and with great constancy contain each seven stigmata. The internal longitudinal vessels bear opposite each transverse a large spatulate papilla, and along the larger transverse bars there extends a very delicate membrane. There are occasionally fine transverse bars between those already described; no papillæ are present at their intersection with the

longitudinal vessels. The interstigmatic vessels are finer than the stigmata (Plate xxvii., fig.19).

*The endostyle* is very conspicuous; its course is very serpentine, the loops being deeper than broad.

*The dorsal lamina* (Pl.xxvii., fig.18) is represented by numerous long languets.

*The dorsal tubercle* is small, obtuse cordate, with the ends turned in (Pl. xxvii., fig.14).

*The tentacles* are very numerous, varying slightly in length, but without regularity.

*The genital gland* is situated in the intestinal loop; the vas deferens is a conspicuous object of light salmon-pink colour, attached to the rectum along its inner side. At its termination, just below the anus, there is a brilliant vermilion swelling.

*The alimentary canal*.—The œsophagus opens from the branchial sac far back, almost at its posterior end, and is quite a short tube. The stomach is oval in shape, placed at the extreme posterior end of the body. The gut immediately beyond the stomach curves sharply forward and slightly dorsalwards; one-third of the way up the body it again bends sharply, ventralwards and back to the posterior end; once more it turns forward, and, passing up the dorsal side, reaches to the base of the atrial siphon (Pl. xxvii., fig.17).

The specimens, from which this description is drawn, will be presented to the Australian Museum.

#### CIONA INTESTINALIS var. DIAPHANEA, Quoy & Gaimard.

*Ascidia diaphanea* Quoy & Gaimard, Voy. de l'Astrolabe, Zool. iii., 1835, p.612, pl.91, figs.10-11.

During April, 1903, the late Mr. Alexander Morton sent me a small collection of Tunicata dredged in Hobart Harbour. The most abundant species in the collection is that which I propose to associate with the above name. Besides this form, there is another with a diaphanous test, *Corella valentinae* (*infra*). The identification, it must be admitted, is very doubtful; it rests on the facts that *A. diaphanea* was obtained in large numbers from

moderate depths near Hobart Town, and had eight-lobed apertures, the lobes being each ornamented with a red spot. Quoy & Gaimard's figure depicts neither of these forms, nor has either of them the branchial aperture at one end and the atrial close to the other, making a right angle with the former. The form which I associate with the name is abundant, as described, has eight lobes to the branchial and six to the atrial aperture, the lobes being ornamented with pink spots. *Corella valentineae* has seven lobes to the branchial and five to the atrial aperture; pigment spots are present between the lobes, not on them.

One is fairly safe to conclude that the French writers had one of these species, since they are both common in the locality whence theirs came; the probability is that they had both, so that, notwithstanding the discrepancies, one may confidently apply this name to one of them. I have selected the *Ciona* on the character of the branchial aperture, and the fact that it is more common than the *Corella*.

This variety differs from var. *sydneyensis* in the following characters.

*The branchial sac* has not the same regularity, the finer transverse bars varying in diameter; usually they are much wider than in the Port Jackson form, so that the stigmata are relatively shorter and wider. There are about eight stigmata to a mesh.

*The dorsal tubercle* has the arms curved rather more inwards.

Apart from these features, no difference can be detected; the characters of the branchial sacs, however, are constant in both forms and will usually serve to distinguish them.

Portion of the material which I have studied will be presented to the Australian Museum.

CORELLA VALENTINÆ, sp.nov.

(Plates xxv., figs.6-8; xxvi., fig.9; xxvii., figs.6-10).

*External appearance*(Pl.xxvii., figs.9-10)—Owing to the softness of the test, all the specimens are more or less distorted; apparently they were of ovoid shape, the long axis being dorsi-ventral. Both siphons are anteriorly situated nearer to the ventral than to the

dorsal edge; the posterior end is flattened and was attached to a plank. Both siphons are well developed; the branchial is the larger. The branchial siphon is seven-lobed, and between the bases of the lobes are seven short brown lines. The atrial siphon is five-lobed.

*The test* is cartilaginous, thin and transparent, tinged green and yellow. The body within is clearly visible through the test. Test-cells are numerous; stellate (rare) and fusiform types are present. Bladder cells are present in fair abundance, but vessels and pigmented cells are absent.

*The mantle* is delicate, translucent, and does not adhere to the test except in the siphons. There is an irregular network of muscle-bands on the left side and anteriorly between the siphons.

*The branchial sac* (Pls. xxv., figs. 7-8; xxvi., fig. 9) is fairly strong and quite devoid of folds. Its general appearance is well shown in the microphotograph (Pl. xxvi., fig. 9); the details are complex. The transverse vessels given off from the ventral sinus branch and anastomose to form a complex network (Pl. xxv., fig. 7); all these are in one plane on the outer side of the sac. The interstigmatic vessels are spirally coiled, and the vortices are conical, their apices directed inwards. In a plane just above, within, that of these apices there is another reticulation of vessels, all of finer calibre than those of the outer network. The most regularly arranged members of this inner reticulum are transverse vessels, usually, though not constantly, equidistant. These inner transverse vessels are not arranged in any constant relation to the vortices; sometimes (Pl. xxv., fig. 8) they pass on either side, at others across the centre of the vortex. The fine irregular vessels given off from these pass to the interstigmatic vessels or anastomose among themselves. The internal longitudinal vessels are quite regular in their arrangement, and are related to the inner transverse vessels exactly as depicted in the figure (Plate xxv., fig. 8). The meshes of the outer reticulum may contain two, three, or even four vortices, usually only one.

*The endostyle*, commencing beyond the œsophageal aperture, sweeps round the sac without undulations. The circumœsophageal bands have an even curve.

*The dorsal lamina* (Pl. xxv., fig. 6) is represented by a series of fairly stout languets placed rather far apart.

*The dorsal tubercle* (Pl. xxv., fig. 6) is circular; the aperture is curved so as to include a cordate area; the arms are sharply turned back but do not extend beyond the area.

*The tentacles* (Pl. xxv., fig. 6) are very numerous (about sixty), fine filiform processes fringing the branchial aperture, not long enough to meet across it.

*The genital gland* is situated in the intestinal loop, and, with the stomach and intestine, makes a compact visceral mass.

*The alimentary canal*.—The œsophageal aperture is situated at the postero-dorsal end of the sac (Pl. xxvii., fig. 6). The œsophagus is short, slender and very delicate; it leads into the wide flattened stomach. The wall of the stomach is thrown into irregular longitudinal ridges. The intestine and rectum are not defined, one from the other. The stomach and intestine lie posterior to the branchial sac, slightly to the right; the intestine is on the left hand side of the stomach. The rectum passes up nearly to the base of the atrial siphon along the dorsal edge of the body (see figs. 6-7, Plate xxvii.).

*Hab.*—Hobart Harbour; 5 fathoms (A. Morton).

*Types* to be presented to the Australian Museum.

This is apparently a fairly common species; there are altogether nineteen specimens in the collection, mostly in clusters of two to four; there is also one cluster made up of four specimens of this species, and three of *Dendrodoa gregaria* Kesteven (*infra*). Since all the specimens have been squashed and distorted, it is not possible to give accurate measurements; a fairly typical example which was carefully distended gave the following dimensions. Length exclusive of siphons 2, breadth (dorso-ventral) 2.5, thickness (lateral) 1.5 cm.

The novelty is distinguished from the other members of its genus by the lobation of the siphons, and the situation of the viscera. Since both these characters necessitate a modification of the generic description, the question arose as to whether it

might not be preferable to propose a new genus. In view of the fact that the number of siphonal lobes may vary within other genera (cf. *Ascidia decemplex* Sluiter) I have thought it better to adopt the present course.

This species is named for my wife.

MOLGULA MORTONI, sp. nov.

(Plates xxv., figs. 4-5; xxvi., fig. 8; xxvii., figs. 11-12).

*External appearance* (Pl. xxv., fig. 5).—The shape is roughly ovoid. Length 23, breadth (dorso-ventral) 27, thickness (lateral) 17.5 mm. The anterior surface is domed, its even surface being broken by the prominences on which the apertures are situated, and by a ridge between these. The left side and the two ends are evenly convex, the right side is flattened; it was attached to a plank by this side. The colour is a dark grey passing into dusky tan in the neighbourhood of the siphons, and on the ridge between them. The branchial aperture is six-, the atrial four-lobed.

*The test* is moderately thin but comparatively opaque, and leathery; on the inner side it is white and has a satin sheen. The external surface is devoid of processes and sand-grains, and, but for very small closely placed pustules on the siphonal areas, is smooth or only slightly wrinkled. Test-cells are very numerous; they are of elongate-fusiform shape. Around the widely separated vessels are clustered cells of irregular shapes which are possibly phagocytes. The ectoderm adheres to the test, and comes away in patches attached to its inner side. Peculiar cell-clusters, resembling solid morula embryos, are also present in the test.

*The mantle* is strong and opaque, its opacity being largely due to the presence of a black pigment. Muscle-fibres are present in abundance arranged quite irregularly, no definite bands being formed. The alimentary canal and gonads are deeply imbedded in the mantle, and therefore visible through it (Pl. xxvii., fig. 11).

*The branchial sac* (Pl. xxvi., fig. 8) bears seven strong folds on either side, whose relation to endostyle, dorsal lamina, and the two apertures, is shown diagrammatically by fig. 12, Pl. xxvii. The



irregularity of the transverse and interstigmatic vessels makes it difficult to describe the mantle in detail. Each fold bears four or five internal longitudinal vessels, and there are either three or four in the interspaces; these latter are finer than those on the folds, and are close together beneath the folds; in the preparation photographed (Pl.xxvi., fig.8) they have been brought into view by cutting away a fold. The arrangement of transverse and interstigmatic vessels is almost regular and rectangular on the folds, but is very irregular in the interspaces; true vortices are rare; only one is shown in the microphotograph at the top.

*The endostyle* extends from the dorsal end of the sac to the circumœsophageal bands without undulation. The circumœsophageal bands have a very undulatory course (Pl.xxv., fig.4).

*The dorsal lamina* (Pl.xxv., fig.4) is a simple membrane, not ribbed or toothed. Owing to the approximation of œsophageal and branchial apertures, the lamina is short; apparently it does not extend beyond the former aperture dorsally.

*The dorsal tubercle* (Pl. xxv., fig.4) is somewhat rhomboid in outline, with well rounded corners. The aperture upon it is sigmoid, each arm ending against an oval opaque-white area. The lips of the aperture are opaque-white, due to the closely packed ciliated cells lining it; and the two areas at the ends of the arms are apparently ovoid chambers, probably similarly lined.

*The tentacles* are about sixteen or twenty in number, they are arched over and completely close the branchial aperture. Each tentacle consists of a stout tapering rachis about 3 millimètres long, and 0.3 of a millimetre broad at its base, bearing on either side a series of pinnæ, which in turn bear pinnules; the pinnæ of the base are scarcely longer than those of the apex; their pinnules may bear secondary pinnules. The length of the central rachis varies slightly, but without regularity.

*The genital glands* are situated on either side of the body; that on the left side is in two portions, one of which is situated in the rectal loop, the other posterior to the intestine (Pl. xxvii., fig.11). The second gland is situated in the middle of the right side; all are attached to the mantle.



*Alimentary canal.*—The œsophageal aperture is situated anteriorly almost directly beneath the atrial siphon, and close to the branchial aperture; from here the gut passes posteriorly and ventrally along the left side; sweeping round anteriorly again, it turns abruptly back on its course and returns to its starting point parallel and close to itself, so that the intestinal loop is very narrow. There are no macroscopic features indicating the various regions of the gut (Pl.xxvii., fig.11).

*Hab.*—Hobart Harbour, dredged 5·11 fathoms (A. Morton.)

*Type* to be presented to the Australian Museum.

The novelty is named for the late Mr. Alexander Morton, who collected and presented it to me.

This *Molgula* is of typical shape, but is atypical in the absence of sand-grains and processes of the test, and also in being attached. The branchial sac, in its regularity on the folds and rarity of vortices, presents an intermediate condition towards *Ascopera*.

DENDRODOA GREGARIA, sp.nov.

(Plates xxv., figs.1-3; xxvi., fig.7; xxvii., figs.1-5).

*External appearance.*—The shape is extremely variable. Both apertures are anteriorly situated, on more or less prominent pustulose areas; both are four-lobed. The most prevalent form is that represented in outline by figure 3, Plate xxvii., roughly pyramidal, the apex being the branchial siphon; on the other hand that contour may be turned upside down, as it were, as represented by figure 4; other individuals are roughly quadrangular (fig. 1) or globular. The colour is dull grey in exposed parts, dusky tan round and between the siphons; and in specimens growing in clusters, the contiguous portions are silvery white. The resemblance between this species and *Molgula mortoni* is very close, the latter differing only in being more globular.

*The test*, in macroscopic features, resembles that of *M. mortoni*, differing only in being a little thicker. Test-cells are very numerous, ovoid and fusiform, the former much the more abundant; stellate cells are not present. Phagocytes (?) are also

numerous, spherical or spherical-crenated without vacuoles, or irregularly distended by vacuoles. The ectoderm adheres closely to the test, and a thin strip taken at random from the inside always bears several patches. The phagocytes (?) take a darker stain than the squames of the epithelium, and may be *clearly* seen among them, as well as throughout the test. Large bladder-cells are present, and some of these certainly have the appearance of being filled with smaller cells. Typical vessels are not well developed, and one of the preparations made shows the presence of peculiar branched vessels of small lumina, and lined by high columnar epithelium.

*The mantle* is strong and semitransparent; it adheres very closely to the test. Fine retractor bands are developed round both siphons (Pl.xxvii., fig.1), and muscle-fibres are matted throughout the whole mantle.

*The branchial sac* (Pl. xxvi., fig.7) is weak though fairly thick, and is difficult to detach from the mantle intact. There are four strong folds on either side; their relation to endostyle, dorsal lamina and the two apertures is shown diagrammatically in fig. 5, Plate xxvii. The rear ethree internal longitudinal vessels in the interspaces, four on the sides and one on the crest of each fold. Transverse vessels are of very various sizes (Pl. xxvi., fig.7) and irregular arrangement. Where most regularly arranged, three sizes can be recognised; between each pair of the largest, are three of medium size, and alternating with them are those of the smallest size. In places these last are represented by anastomoses of the interstigmatic vessels, rather than by definite vessels, and in other places are not developed at all. Occasionally the interstigmatic vessels are very much enlarged; such enlarged vessels may extend across three or four meshes. Fine membranes are present along a few of the transverse vessels. There are about twelve stigmata to a mesh near the base of the folds, and about six on either side of the crest. On either side of the endostyle the meshes are very broad and contain upwards of twenty-five stigmata. The interstigmatic vessels are rather finer than the stigmata.

*The endostyle* extends from just dorsal to the œsophageal aperture, round the sac without undulation to near the circum-œsophageal bands, where it presents a deep double loop (Pl. xxvii., fig.5). The circumœsophageal bands have an even curve without undulations.

*The dorsal lamina* is a plain undulating membrane, devoid of teeth and ribs.

*The dorsal tubercle* (Pl. xxv., fig.3) is oval in outline, the longer axis being transverse. The aperture is curved so as to include a somewhat cordate area. The subneural gland is a pyriform body lying beneath the nerve.

*The tentacles* are numerous (Pl. xxv., fig.3), simple filiform processes. Two grades of size are distinguishable; the larger are about twenty in number, those of smaller size about twice as numerous. Their arrangement is quite irregular, and intermediate sizes are present.

*The genital gland* is in the form of a large number of small lobes attached to the mantle on the right side (Pl. xxvii., fig.1).

*The alimentary canal* is divided into regions clearly recognisable from changes in colour or size. The situation of the various parts is shown in outline by figure 2, Plate xxvii. The œsophagus is a short slender tube, very delicate and of a dull grey colour; its lumen is triradiate in cross-section. The stomach (Pl. xxv., fig.2) is oval in shape, yellow in colour, and bears numerous oblique folds, which extend from a smooth area, along the centre of the left side, backwards and to the right side. The intestine is yellow in colour; and the rectum, which commences on the intestinal loop, is dark green. The intestinal loop is neither wide nor narrow, but intermediate.

*Hab.*—Hobart Harbour; 5 fathoms (A. Morton).

*D. gregaria* is apparently a common form; there are upwards of thirty specimens in the collection; they were attached by the posterior end; clumps of three or four are common, but there is no tendency to fusion of the tests.

*Types* to be presented to the Australian Museum.

*Dendrodia gregaria* is apparently very like *Styela radicata* Herdman, from which it differs in having no root-like processes

to the test, and in the number of internal longitudinal vessels on fold and interspace in the mantle, as well as in the character and situation of the gonads; that is, if the generic name applied by Herdman may be taken for a description of his species.

Herdman\* has expressed the opinion that *Dendrodoa* "should be merged in *Styela*"; the present species, however, has the genital gland in the form characteristic of *Polycarpa*. If *D. glandaria* MacLeay, is to be regarded as a *Styela*, then *D. gregaria* Kestv., must be placed in the genus *Polycarpa*.

All of the Hobart material discussed in this paper was obtained by the late Mr. Morton, attached to a large wooden box raised from a depth of 5 fathoms. Since upwards of one hundred specimens were so obtained, the abundance of Tunicata in Hobart Harbour must be very great.

In concluding, I wish to thank Professor Anderson Stuart, in whose laboratory this work has been done.

#### EXPLANATION OF PLATES XXV.-XXVII.

##### Abbreviations.

A., anus—Atr. Ap., atrial aperture—Br. Ap., branchial aperture—D.L., dorsal lamina, or dorsal languets—End., endostyle—Emb., tailed larvæ—Flds., branchial folds—G., subneural gland—Gon., gonad—N.G., nerve ganglion—Oes., œsophagus—Ov., ovary—R., rectum—St., stomach—T., tubercular diverticulum of the cloacal chamber—V.D., vas deferens.

The outlines in every case were obtained with camera lucida or reflecting prism.

##### Plate xxv.

Fig.1.—*Dendrodoa gregaria* Kestv.; seen from above.

Fig.2.— " " " stomach.

Fig.3.— " " " dorsal tubercle and related parts.

Fig.4.—*Molgula mortoni* Kestv.; dorsal tubercle and related parts, seen from above.

Fig.5.—*Molgula mortoni* Kestv.; complete specimen, seen from above.

Fig.6.—*Corella valentinæ* Kestv.; dorsal tubercle and related parts.

Fig.7.— " " branchial wall, atrial aspect.

Fig.8.— " " " " branchial aspect; diagrammatic.

Fig.9.—*Sidneioides tamaramæ* Kestv.; a single zooid.

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\* Challenger Report, Tunicata, Pt. i., p.148.

## Plate xxvi.

- Fig.1.—*Sidneioides tamaramæ* Kestv.; section of ovary.  
 Fig.2.—       "       "       "       anterior end of zooid.  
 Fig.3.—       "       "       "       a test-cell.  
 Fig.4.—       "       "       "       portion of thorax.  
 Fig.5.—       "       "       "       colony from above.  
 Fig.6.—       "       "       "       portion of a colony, from the side.  
 Fig.7.—*Dendrodoa gregaria* Kestv.; branchial wall.  
 Fig.8.—*Molgula mortoni* Kestv.; branchial wall.  
 Fig.9.—*Corella valentineæ* Kestv.; branchial wall.

Fig.1 is reproduced from a drawing on a faint bromide print, from a microphotograph which, together with figs.5, 6, 7, 8 and 9, were taken for me by Mr. Louis Schaeffer, of the Anatomy Department.

## Plate xxvii.

- Fig.1.—*Dendrodoa gregaria* Kestv.; outline of body removed from the test, seen from the right.  
 Fig.2.—       "       "       "       outline of body removed from the test, seen from the left.  
 Fig.3.—       "       "       "       outline of complete specimen.  
 Fig.4.—       "       "       "       outline of complete specimen.  
 Fig.5.—       "       "       "       half branchial sac, from within.  
 Fig.6.—*Corella valentineæ* Kestv.; showing the situations of the parts seen in and through the branchial wall.  
 Fig.7.—       "       "       "       body removed from the test, dorsal aspect.  
 Fig.8.—       "       "       "       body removed from the test, ventral aspect.  
 Fig.9.—       "       "       "       complete specimen.  
 Fig.10.—       "       "       "       complete specimen.  
 Fig.11.—*Molgula mortoni* Kestv.; body removed from the test, seen from the left.  
 Fig.12.—       "       "       "       half branchial sac, seen from within.  
 Fig.13.—*Ciona intestinalis* Linn., var. *sidneiensis* Stimpson; anterior end of body removed from the test, seen from the left.  
 Fig.14.—*Ciona intestinalis* Linn., var. *sidneiensis* Stimpson; dorsal tubercle and related parts.  
 Fig.15.—*Ciona intestinalis* Linn., var. *sidneiensis* Stimpson; body removed from the test, seen from the right.  
 Fig.16.—*Ciona intestinalis* Linn., var. *sidneiensis* Stimpson; body removed from the test, seen from the left.  
 Fig.17.—*Ciona intestinalis* Linn., var. *sidneiensis* Stimpson; diagrammatic outline showing situations of gonad, vas deferens and alimentary canal.  
 Fig.18.—*Ciona intestinalis* Linn., var. *sidneiensis* Stimpson; dorsal languets.  
 Fig.19.—*Ciona intestinalis* Linn., var. *sidneiensis* Stimpson; branchial wall.